The global fit to electroweak data

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abstract

The global fit to electroweak data is given. The Standard model is in a good shape and is consistent. The new BES measurements of R_{had} are used in the determination of the hadronic contribution to the running of α. Using these measurements, data still prefer low m$_H$, but less low.

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THE GLOBAL FIT TO ELECTROWEAK DATA

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The global fit to electroweak data is given. The Standard model is in a good shape and is consistent. The new BES measurements of R_{had} are used in the determination of the hadronic contribution to the running of α. Using these measurements, data still prefer low m_H, but less low.

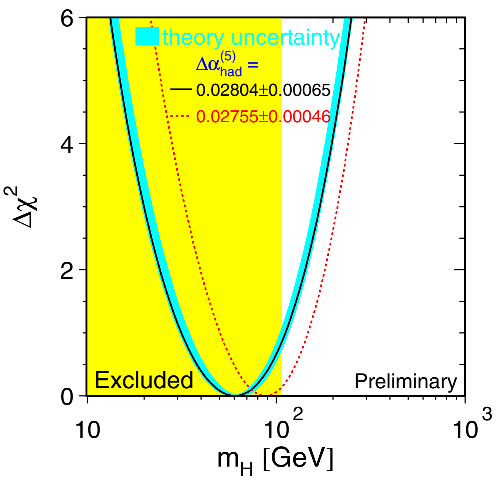

Figure 1. $\Delta\chi^2$ distribution of the Standard Model fit results as a function of the Higgs mass m_H. Official fit results are shown by the solid line, the dotted line represents fits results with the $\Delta\alpha^{(5)}_{had}(s)$ obtained here.

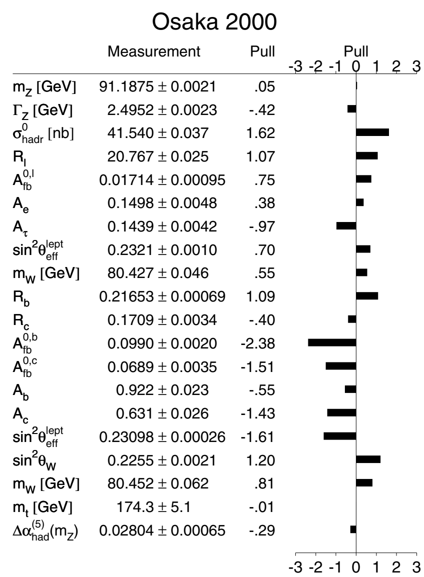

Figure 2. Input values to the fit and the pulls.

Beautiful experimental results have been presented in this session. These results are used in the global fit to electroweak data in which the validity of the Standard Model (SM) is assumed. In this fit the consistency of the Standard Model is tested. The value of the Higgs mass is extracted from the measurements of radiative corrections.

Figure 1 shows the $\Delta\chi^2$ distribution of the fit results. The central value of the Higgs mass is

$$m_H = 60^{+52}_{-29}\ \text{GeV}$$

The one-sided 95%CL (90% two-sided) upper limit on m_H is 165 GeV.
This value was $66.5\pm^{+60}_{-33}$ in Moriond in spring 2000, so the change is small. The largest contribution to the change comes from the change in the value of m_W. In this analysis the most advanced fitting programs ZFITTER and TOPAZ0 are used. The band around the solid line represents theoretical uncertainties obtained by comparison of results of two fitting programs, and also by varying the different implementations of higher order corrections in these programs in order to estimate the size of the remaining even higher order terms. The shadowed region is excluded by direct searches.

Input values to the fit and the pulls are shown in figure 2. The χ^2/d.o.f. is 21/15, giving a reasonable probability of 12%. The only pull above 2 comes from the $A^{0,b}_{fb}$ measurement. The pull of the A_{LR} measurement

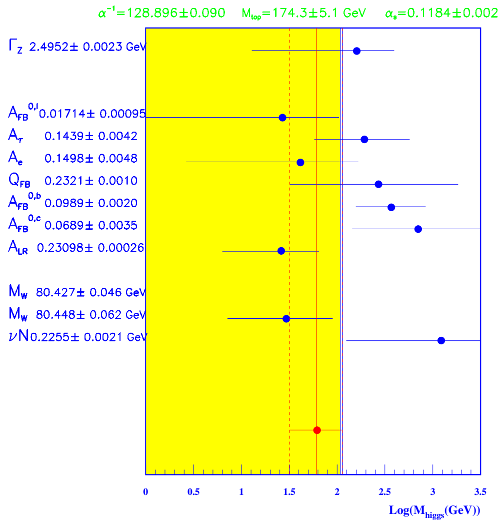

Figure 3. The results of the Higgs mass fit to different measurements.

is 1.6.

The results of the Higgs mass fit to different measurements is shown in figure 3. A reasonable distribution of the results of these fits around the central value is observed. Three measurements $A_{FB}^{0,l}$, A_{LR} and m_W give central value of m_H of about 30 GeV.

The numerical values of fit results are given in reference[1].

Very good consistency of the Standard Model is observed in figures 4, 5, 6 by comparing fit results with the direct measurements.

Figure 7 shows the fit results and the Standard Model predictions in the M_W, Γ_l plane. The Standard Model prediction is also shown when radiative corrections are restricted to the running of α alone. The genuinely electroweak radiative corrections are clearly seen. These corrections, from measurements of which the Higgs mass value is obtained, depend also strongly on the top contribution.

Thus, in order to determine the central value and the error of the Higgs mass one has to know precisely the central values and the uncertainties on α and m_t. The strong

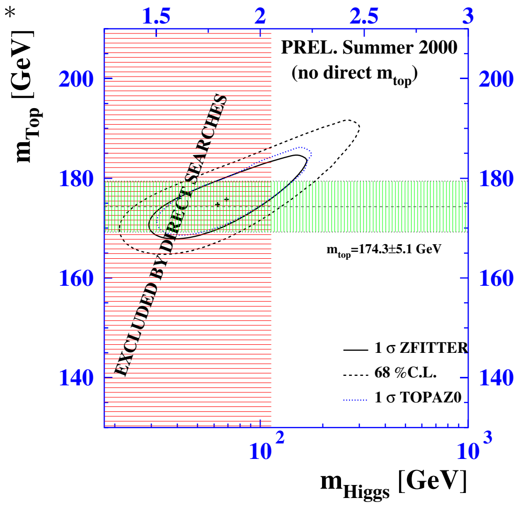

Figure 4. Consistency of the SM.

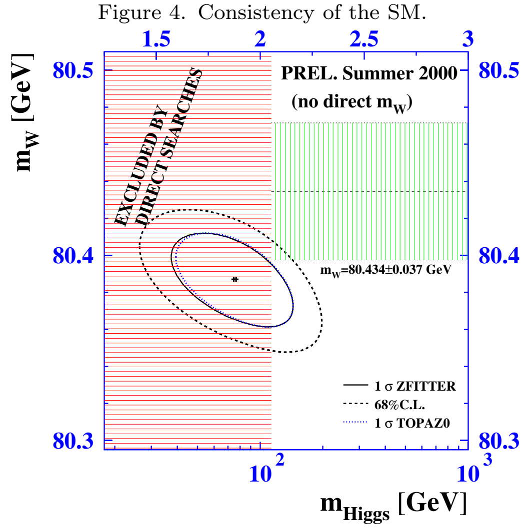

Figure 5. Consistency of the SM.

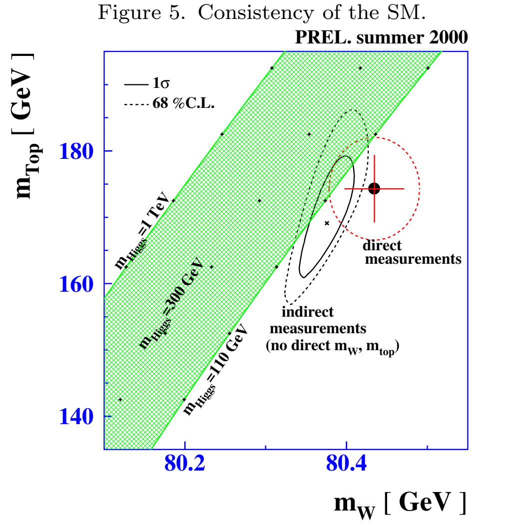

Figure 6. Consistency of the SM.

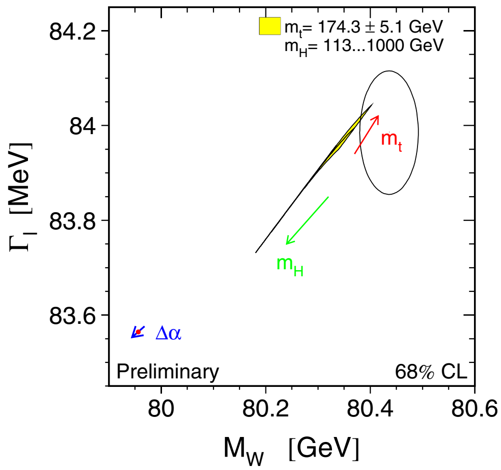

Figure 7. The fit results and the Standard Model predictions in the M_W, Γ_l plane.

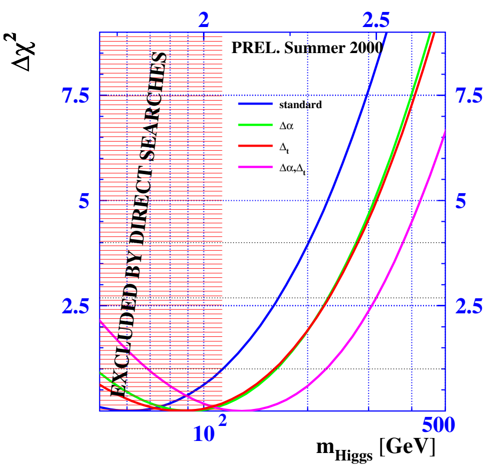

Figure 8. The dependence of the fit results on the variation of central values of α and m_t.

dependence of the fit results on the variation of central values of α and m_t is shown in figure 8. The central value of α^{-1} is changed by 0.09 (1σ), and the central value of m_t by 5.1 GeV (1σ) in the direction which increases the value of m_H in the fit output.

α is running :

$$\alpha(s) = \frac{\alpha(0)}{1 - \Delta\alpha_l(s) - \Delta\alpha^{(5)}_{had}(s) - \Delta\alpha_{top}(s)}$$

The contribution of the leptonic loops $\Delta\alpha_l(s)$ is precisely known[2]. The contribution of quark loops is obtained by integrating the R_{had} distribution measured in e^+e^- annihi-

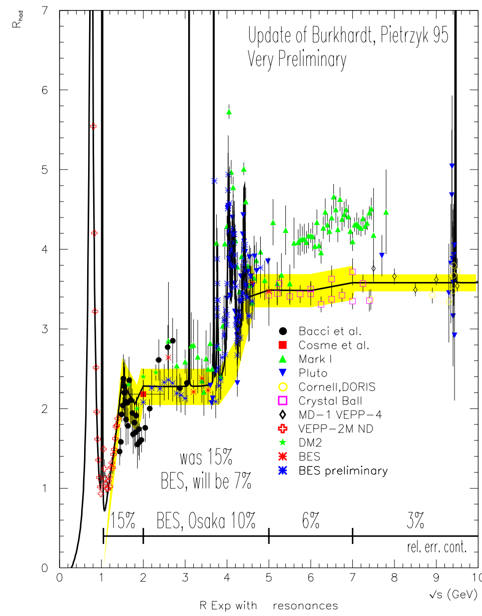

Figure 9. The results of R_{had} measurements with 85 preliminary and 6 published points of BES.

lation.

$$\mathrm{Re}\,\Pi_{\gamma\gamma}(s) = \frac{\alpha\ s}{3\pi}\ \ P\int_{4m_\pi^2}^{\infty} \frac{R_{had}(s')}{s'(s'-s)}ds'$$

The BES collaboration reported[3] at this conference the new preliminary measurements of R_{had} in the c.m.s region 2-5 GeV. The 85 preliminary points together with the 6 published ones (figure 9) are used in a very preliminary update of the results of calculations in reference[4]. The value of
$\Delta\alpha^{(5)}_{had}(s) = 0.02755 \pm 0.00046$
is obtained corresponding to
$\alpha^{-1} = 128.945 \pm 0.060$.
The central value is changed by 0.7σ in comparison with the published[4] value of 0.0280 ± 0.0007.

The values of R_{had} measured by BES are generally lower than the earlier data used in the previous analysis both in the low energy region (figure 10) and in the charmonium region. The solid line in figure 10, used in the $\Delta\alpha^{(5)}_{had}(s)$ analysis, is now closer to the perturbative QCD prediction[5] (figure 10).

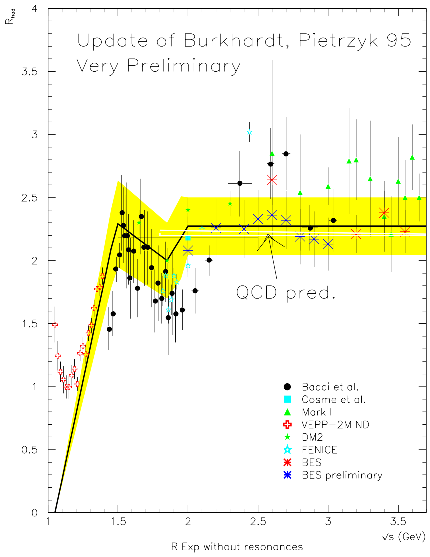

Figure 10. The results of R_{had} measurements in the low e^+e^- c.m.s. energy region.

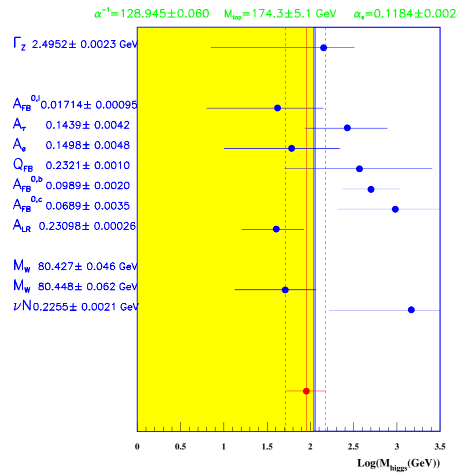

Figure 11. The results of the Higgs mass fit to different measurements using the value of $\Delta\alpha^{(5)}_{had}(s)$ obtained here.

Fits of the Higgs mass to different channels are repeated using the new value of α (figure 11). The central values of different measurements are shifted to the higher values and those of $A^{0,l}_{FB}$, A_{LR} and m_W give the $\Delta\chi^2$ minima at 40-50 GeV.

The change in the $\Delta\chi^2$ distribution using the new value of $\Delta\alpha^{(5)}_{had}(s)$ is shown by the dotted line in figure 1. The $\Delta\chi^2$ minimum moves to about 88 GeV and the one-sided 95%CL upper limit moves to 210 GeV.

In conclusion :

- the Standard Model is still in good shape
- the Standard Model is consistent
- the most significant changes are :
  - BES R measurements, not yet included in the official fit results
  - m_W from LEP
  - Z lineshape is now final, but preliminary numbers were already very good
- the data prefer a low Higgs mass

  official fit results $\rightarrow m_H = 60^{+52}_{-29}$ GeV,
  $m_H < 165$ GeV
- using BES R measurements, the data still prefer low m_H, but less low

thanks to :
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